Economic Determinants of Jute Production in India and Pakistan

by

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I. RELATIONSHIP BETWEEN RICE AND JUTE CULTIVATION IN INDIA AND PAKISTAN

Most of the world's jute is produced within the predominantly rice-growing areas of India and Pakistan. Rice is grown as the staple food crop, while jute is the principal cash crop of the farmers of the jute belt. In Pakistan, acreage under jute normally accounts for 6 per cent of the total sown area in the jute-growing districts, while rice acreage extends to more than 80 per cent of the total. In the jute-growing districts of the Indian Union, although the proportion of the total sown land under rice is lower than in East Pakistan, rice acreage is normally 15 to 20 times as extensive as the total jute acreage. The scope for variation in jute cultivation is, therefore, potentially large in both India and Pakistan.

This paper seeks to analyse the large variations in jute acreage that is observed annually in India or Pakistan. It is concerned with the formulation of statistical models and testing of the Indian or Pakistan jute farmers' response to prices and other economic factors. In Section I, the relationship between jute and rice cultivation in India and Pakistan is discussed. In Section II the statistical models are formulated and applicability to farmers' response in India and Pakistan is discussed. In Sections III and IV statistical fit of the models to both pre-Partition and post-Partition data are tested. In the final Section V, conclusions on determinants of the long term trends in India and Pakistan have been drawn.

Cultural operations of jute and rice and particularly their timing reveal a close competitive relationship between the two crops. Two main varieties of jute are grown in India and Pakistan: *corchorus capsularis* or white jute, which grows equally well on high land (normally no flooding) and low land (normally subject to flooding) and *corchorus olitorius* or tossa jute, which does not tolerate waterlogged conditions and is grown only on high lands where there is sufficient drainage. In East Pakistan, white jute normally accounts for two-thirds of the total production [20, p. 69]. The proportion of white jute in West Bengal is almost of the same proportion, but considerably higher in the rest of the jute-

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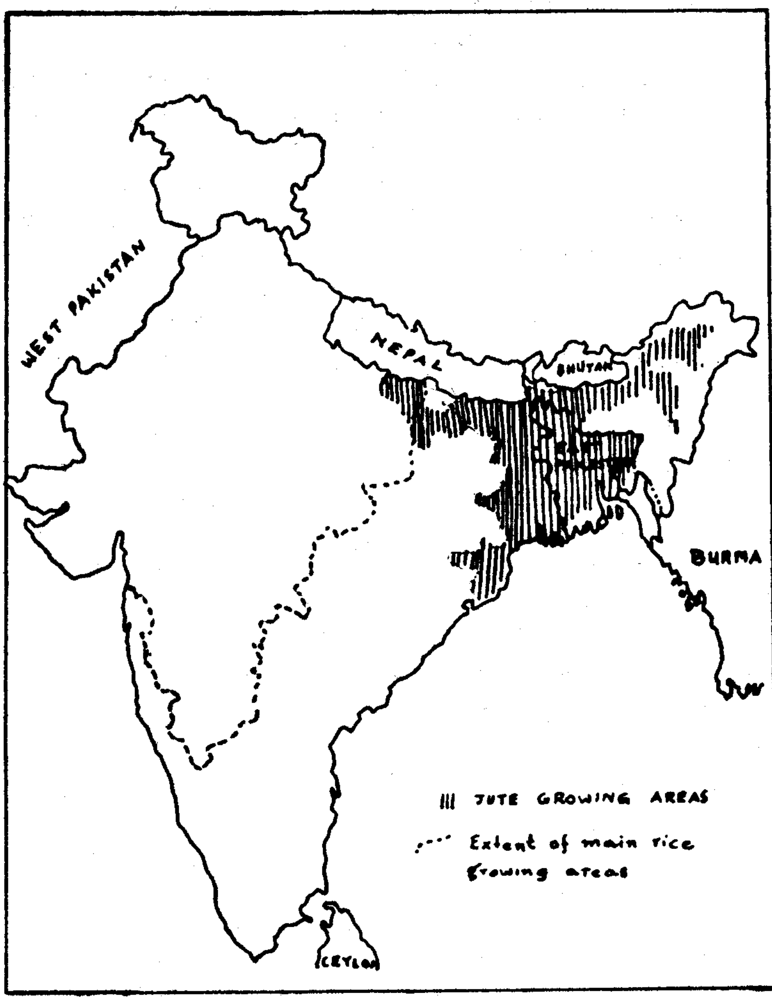

Figure 1. Jute Belt and Main Rice Growing Areas of India and Pakistan

TABLE I

JUTE AREA AS COMPARED WITH AREA UNDER RICE AND OTHER CROPS IN THE JUTE-GROWING DISTRICTS OF INDIA AND PAKISTAN

Crop	Pre-Partition British India[1] 1938/39-1942/43		Post-Partition Indian Union[2] 1955/56-1959/60		Bengal[3] 1938/39-1942/43		East Pakistan[4] 1955/56-1959/60	
	Acreage (million)	% of total	Acreage (million)	% of total	Acreage (million)	% of total	Acreage (million)	% of total
Rice	33.3	70	38.4	60	22.15	73	20.1	83
Jute	3.5	7	1.8	3	2.87	10	1.5	6
Other crops	12.0	23	23.1	36	5.40	17	2.6	11
Total sown area	48.8	100	63.9	100	30.42	100	24.2	100

Sources: Col. (1) Total sown areas in the jute-growing districts of British India: calculated from [12].
Col. (2) Total sown areas in the jute-growing districts of the Indian Union: calculated from [11].
Col. (3) Total sown areas in the jute-growing districts of pre-Partition Bengal: calculated from [12].
Col. (4) Total sown areas in the jute-growing districts of East Pakistan: calculated from [21].

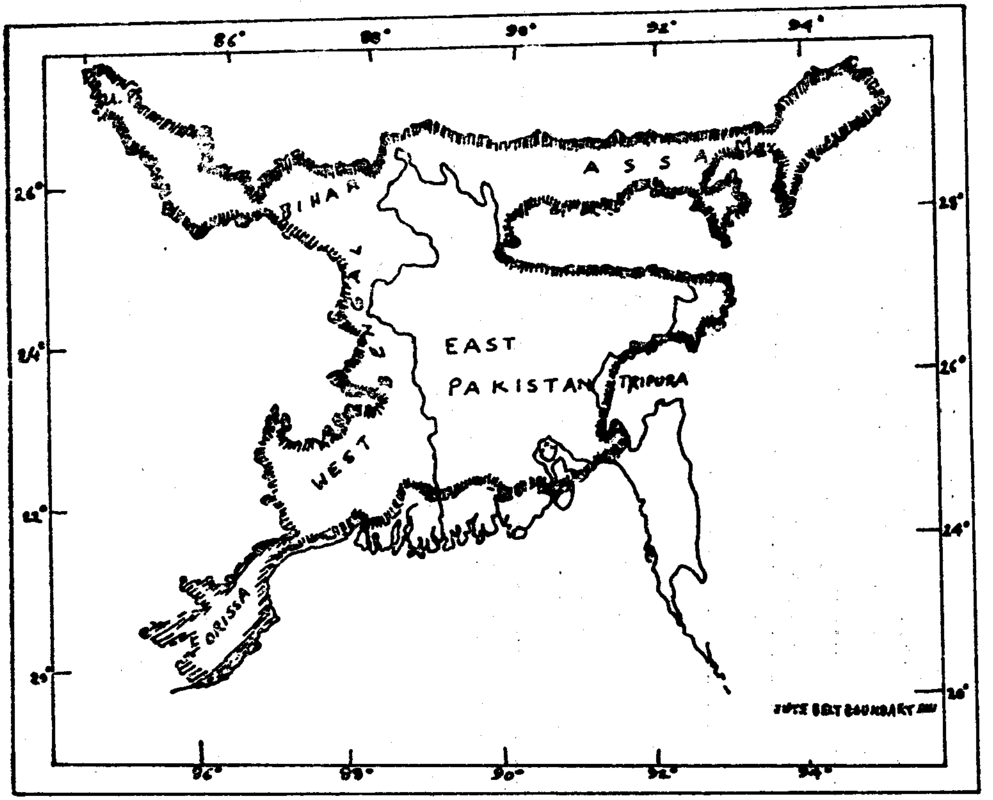

Figure 2. Jute Belt of India and Pakistan

growing areas of the Indian Union [8, pp. 55 and 57]. Lowland jute is the earliest to be planted—from about mid-February to mid-March. Sowing of highland jute occurs during April and early May. The lowland white jute harvest usually starts in June immediately following the commencement of the monsoon and extends into August. Tossa jute is generally harvested in August and September, although the harvesting season sometimes extends into October.

Like jute, two main varieties of rice—*aus* and *aman*—are grown[1] in the jute districts of India and Pakistan. *Aus* is autumn-harvested rice, and its season coincides with the jute season. It offers no opportunities of double cropping with jute, and its cultivation has to be foregone when jute is grown on the same land.

Aman is the winter-harvested rice which accounts for four-fifths of the annual production of rice in the jute belt. It is harvested mainly in November and December; its season is, therefore, later than the jute season, but sowing or transplanting of *aman* rice overlaps the maturing and harvesting periods of jute. Opportunities for double cropping of jute and *aman* rice are limited. After an early jute harvest, late *aman* rice can sometimes be transplanted onto the same land, but it usually involves sacrifices in yield for both crops, and may be defeated entirely if weather and flooding conditions are not just right. The 1958-59 Jute Committee survey in East Pakistan revealed that double cropping of jute and *aman* rice does not extend, on the average, to more than 3.5 per cent of jute growers' land in East Pakistan [20, p. 57]. Elsewhere, for example in the Assam, West Bengal, or Orissa in the Indian Union, double cropping of jute and *aman* rice is limited to less than 1 per cent of the jute growers' land [16].

Jute and rice are pre-eminently products of small-scale peasant farming. Although the average size of jute growers' holdings is somewhat larger than the average of all farmers' holdings, it rarely exceeds ten acres. Three to six acres is the most common size. In East Pakistan the average size of jute growers' holdings is found to be 6.5 acres (*see* Table II). There is, however, some variation in the average size of the holdings from district to district. In the main jute-growing districts, which are also the most densely populated, Mymensingh, Rangpur, Comilla, and Dacca, average size varies from three to six acres; in the peripheral and less densely populated districts, Dinajpur, Kushtia, and Khulna, the average is around ten acres.

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[1] There is a third variety of rice—*boro*, which is essentially a swamp rice harvested in summer.

TABLE II

AVERAGE SIZE OF JUTE GROWERS' HOLDINGS IN EAST PAKISTAN 1958-59 AVERAGE, AND POPULATION DENSITY, 1961

District	Density of population (000) per square mile	Average size of jute grower's holding	Percentage of holding cultivated
Main jute-growing districts:			
Dacca	1909	5.78	91
Mymensingh	1141	4.56	89
Comilla	1794	3.61	83
Rangpur	1130	6.50	86
Peripheral districts:			
Noakhali	1468	3.58	69
Bogra	1075	5.59	88
Pabna	1157	7.92	91
Dinajpur	659	10.99	90
Rajshahi	788	7.43	83
Sylhet	737	7.77	90
Kushtia	882	10.18	83
Faridpur	1311	6.03	87
Jessore	877	7.28	88
Khulna	600	12.03	90
Barisal	1187	5.77	78
Average: East Pakistan	977	6.56	87

Sources: [20; 24].

Nearly 90 per cent of the average jute grower's holding is cultivated, the remainder being fallow and household lands. On the cultivated area, rice and jute account for nearly 90-95 per cent; the rest is accounted for by small crops of pulses, mustard, and vegetables, and in some areas by sugarcane. Most of these latter crops are *rabi* or winter crops. As a result, their cultivation does not normally compete with jute. Only in the peripheral areas of the jute belt of India and Pakistan, such as in parts of the Uttar Pradesh, and Bihar and some districts of East Pakistan (such as Dinajpore, Rajshahi, and Kushtia), cultivation of sugarcane offers an alternative to that of jute. However, in view of the fact that land once diverted to sugarcane stays in the cultivation of sugarcane more or less permanently, competition to jute from sugarcane is of little significance.[2]

The predominance of rice and jute *vis-a-vis* the other crops can be seen from Table III:

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2 Sugarcane occupies the field for ten or twelve months. Its planting begins in March, the acreage planted in the crop year (t) is likely to be more influenced by the harvest price of the year (t-2) than the harvest price of year t-1, since the preparations for planting of the year to begin even before the sugar of the immediately preceding season is harvested. This also precludes the possibility of the competition between jute and sugarcane over most years.

TABLE III

CROPPING PATTERN OF JUTE GROWERS' LAND IN EAST PAKISTAN (1958-59 AVERAGE): PERCENTAGE OF CULTIVATED LAND UNDER DIFFERENT CROPS

District	Acreage of cultivated land in jute grower's holding	Jute	*Aman* as double crop with jute	*Aus*	*Aman*	*Aus* and *Aman* mixed	*Boro*	Total rice	Other crops
Dacca	5.23	17	2	22	29	21	2	76	7
Mymensingh	4.07	16	9	35	20	11	1	76	8
Comilla	3.00	21	7	29	18	14	4	72	7
Rangpur	5.61	17	10	42	15	10	—	77	6
Noakhali	2.48	13	10	6	35	45	—	86	1
Bogra	4.91	16	6	23	43	15	1	82	2
Pabna	7.23	7	0	8	43	35	—	86	7
Dinajpur	9.89	4	2	24	52	1	—	77	19
Rajshahi	6.19	8	—	23	39	11	—	73	19
Sylhet	6.99	16	5	13	53	7	2	80	4
Kushtia	8.46	10	—	37	23	17	—	77	13
Faridpur	5.26	15	1	9	28	43	—	81	4
Jessore	6.40	11	—	40	31	15	—	86	3
Khulna	10.78	6	—	3	91	—	—	94	—
Barisal	4.52	29	9	2	25	44	—	80	11
East Pakistan Average	5.71	13	3	25	35	16	1	80	7

It is now clear that over most of the jute belt of India and Pakistan rice is practically the only alternative to jute cultivation. Cultural practices of the two crops are such that land, labour and equipment are readily interchangeable between their cultivation. In fact, for most farmers of the jute belt, cultivation of jute is primarily a choice between the cultivation of a cash crop in lieu of the staple food crop. In areas where the farmers can devote their land to two crops a year, they have a choice between either two crops of rice or one crop of rice and one of jute. There are, of course, some areas where the choice of an alternative crop does not arise, either because a given land area is only suitable for growing rice alone or jute alone, but these areas are very small in comparison to the areas where the choice has to be exercised [23, p. 37].

Thus in the jute belt of India and Pakistan, rice prices largely determine the opportunity cost of using land for jute cultivation, since rice production is usually to be foregone in order to grow jute. The farmer's choice as to grow more rice or jute in any particular season is, therefore, likely to be influenced by the relative prices of the two crops. More explicitly, by the price of jute the farmer expects to get by marketing the crop (the so-called "harvest price" of raw jute) and by the price of rice he expects to have to pay in order to buy rice (*i.e.*, the "retail price of rice"). In practice, however, there does not appear to be an important difference between the price the grower expects to get for that part of his rice crop which may be surplus to his requirements (*i.e.*, "the harvest price" of rice) and the price he expects to have to pay for rice to supplement his rice production [1]. In general, the need for cash to purchase rice in the lean three months or so immediately preceding the *aman* rice harvest (which coincides with the time when the bulk of the jute crop is marketed in India and Pakistan) is the main incentive for growing jute in the jute belt [1].

II. STATISTICAL MODELS FOR ANALYSING PRICE RESPONSE OF JUTE FARMERS IN INDIA AND PAKISTAN

Price Expectation Model

Price response of primary producers in underdeveloped countries is a much debated topic[3]. However, in the case of a cash crop like jute, the cultural and cultivation practices of which are closely competitive with that of rice, the price response of jute farmers has long been a well-recognised phenomenon [28; 29]. The collective price response of jute farmers is manifested primarily in the form of acreage response, since variations in jute acreage alone is found to account for 85-95 per cent of the annual variations in jute production in India and Pakistan. Variations in the yield rate are found to be mostly random and,

[3] For meaning and measurement of farmer response to price in underdeveloped countries, *see* W.P. Falcon [3].

therefore, largely outside the control of jute farmers under the traditional cultural practices where yield-raising inputs such as fertilizer or better seeds have as yet limited usage. Large fluctuations as observed in the yearly jute acreage in India and Pakistan are primarily a reflection of the choice exercised by the jute farmers each season *vis-a-vis* the cultivation of rice. The traditional role of rice-jute rotation pattern, the widespread familiarity of the farmers with cultivation of both crops, the vast area under rice as compared with jute, and to some extent their agronomic complimentary character makes exercise of this choice easier. It is, therefore, not unrealistic to formulate the general hypothesis that the annual variations in jute acreage over most of the jute-growing areas of India and Pakistan are closely related to the jute farmers' expectation of the relative prices of jute and rice. Once we view the jute farmers' price response this way, a further question arises as to the prices the farmers have in mind in forming an estimate of the relative expected prices. In most of the previous studies on price response of jute farmers in India and Pakistan, the authors have identified the relative prices of jute and rice prevailing in the preceding season as the prices to which the farmers react. Assuming a Nerlovian [19] approach, it would be more realistic to postulate that the jute farmers base their expectation of relative prices on their experience of past prices over a period of years, assuming that the influence of more recent prices would be greater on them than the influence of less recent prices. Given the reasonableness of such an assumption, we may state that in the case of two closely competing crops like jute and rice, the farmer's decision to devote a certain acreage to jute is dependent on the past prices of each crop, together with price expectation for them.

The hypothesis concerning the farmer's price expectations each year can be stated explicitly as follows. The jute farmers revise their expectations each season, and the amount by which they revise their expectation for the coming season is a certain fraction of the error they made in estimating price this season.

Let the fraction by which the jute farmers revise their price expectation be denoted by K. The hypothesis postulating the price response of jute farmers can then be expressed algebraically as follows:

$$A_t = f(P^*_t) \qquad (1)$$

$$P^*_t - P^*_{t-1} = K(P_{t-1} - P^*_{t-1}) \qquad (2)$$

where

A_t = acreage under the jute in year (jute year) t.

P^*_t = expected relative price of jute, *i.e.*, expected price of jute received by farmers relative to retail price of rice in year t.

P^*_{t-1} = expected jute price relative to retail rice price in year t − 1.

P_{t-1} = actual price of jute relative to retail price of rice in year t − 1.

and

K as defined earlier is the Nerlovian coefficient of expectation

and

$0 \leqslant K < 1$ by hypothesis.

Jute and rice prices are incorporated in the model in the form of a ratio. This is reasonable in view of the fact that an extension of jute acreage in any season takes place on rice land progressively more suitable for planting jute. A given proportionate change in price of jute and rice can, therefore, be assumed to be associated with changes in jute acreage. As discussed earlier, the price of rice in fact represents a major element in the "cost" of jute production; hence, using the relative price of jute with respect to retail price of rice is also roughly equivalent to deflating the jute price by an "index" of prices paid by the jute farmers[4].

To derive the acreage response function, we can assume (1) to be linear in P^*_t with a residual term U_t distributed normally and independently, or in other words,

$$A_t = a_o + a_1 P^*_t + U_t \quad \text{..................................(3)}$$

Relation (2) is a first order difference equation in P^*_t, the general solution of which is given by

$$P^*_t = KP_{t-1} + (1-K)\,KP_{t-2} + (1-K)^2\ KP_{t-3} + \text{...............(4)}$$

Substituting (4) in relation (3), we have

$$A_t = a_o + a_1\ [KP_{t-1} + (1-K)\,KP_{t-2} + \ldots] + U_t \quad \text{.....................(5)}$$

Writing similarly the equation for A_{t-1} and multiplying it by (1—K) and subtracting the result from (5), we have

$$A_t = a_oK + a_1KP_{t-1} + (1-K)A_{t-1} + U_t - (1-K)U_{t-1} \quad \text{..............(6)}$$

If we denote a_oK by B_o, $a_1K = B_1$, $(1-K) = B_2$ and $= U_t - (1-K)U_{t-1} = W_t$ Equation (6) can be written more compactly as

$$A_t = B_o + B_1P_{t-1} + B_2A_{t-1} + W_t \text{...(7)}$$

Equation (7) gives the acreage response function. All the variables excepting W_t are now observable. According to this equation, acreage in a jute year t is determined by the relative price of jute and rice last year, and jute acreage last year.

[4] This index is not available for Pakistan. In the case of India, it is available for the states of West Bengal, Assam, and Orissa on calendar year basis since 1950. *See* [5; 10].

Estimation of the coefficient of (7) by the method of least squares would enable us to estimate the coefficients of Equation (3) because of the relationship that exists between the two sets of coefficients.

Although the expectation model, thus developed, would seem to be an appropriate one in the context of jute cultivation in India and Pakistan, it suffers from a couple of drawbacks. The first drawback is that residuals of the model are serially correlated. The second drawback is that it is not feasible to introduce additional shifter or explanatory lagged variables in the model without imposing certain restrictive assumption on the coefficient of the expectation.

Adjustment Model

The difficulties inherent in the expectation model can be avoided if we assume the behaviour of the jute farmers in India and Pakistan to approximate a "Nerlovian adjustment model" instead. The model can be postulated as follows:

$$x^*_t = a + bP_{t-1} + c\,Y_{t-1} + U_t \qquad \text{.....................(1)}$$

$$x_t - x_{t-1} = \lambda(x^*_t - x_{t-1}) \qquad \text{....................(2)}$$

x^*_t is the jute acreage the farmers would plant in the year t if there were no difficulties of adjustment. X_t is the acreage actually planted to jute in the year t. P_t is the relative price of jute, *i.e.*, harvest price of jute deflated by the retail price of rice. Y_t is the relative yield rate of jute, *i.e.*, yield of jute fibre per acre deflated by the yield rate of rice[5]. λ is the Nerlovian coefficient of adjustment and U_t is the random error assumed to be distributed randomly with zero mean.

The adjustment model makes it feasible to introduce the second explanatory and lagged variable, Y_t (the ratio of yields) in our equation for the behaviour of the jute farmers without bringing in additional assumptions regarding λ. The logic behind the inclusion of Y_t is that besides the relative price of jute and rice, the farmer's decision to devote a specific piece of land to jute is likely to be influenced by the relative yields of jute and rice that he expects from it and this expectation is most likely to be based on the experience of the most recent past, *i.e.*, on Y_{t-1}. Inclusion of Y_t will also take into account any likely effect of the trends in the yield rates of jute and rice[6].

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[5] Husked rice. One maund (82.2/7 lbs.) of paddy (unhusked rice) on the average yields approximately two-thirds of a maund of rice in India and Pakistan.

[6] Other shifter variables such as a measure of the rainfall during the sowing or the growing seasons can conceivably be included in the adjustment model. However, a preliminary trial with annual rainfall figures during the sowing season as an additional variable did not show any promising result, so that it was decided not to include this variable in the model.

The basic assumption on which the adjustment model is based is given by the relationship $X_t - X_{t-1} = \lambda (X^*_t - X_{t-1})$. Expressed in words, this means that the jute farmers are able to increase the acreage under jute in any year only to the extent of a fraction λ of the difference between the acreage they would like to plant and the acreage they actually planted in the preceding year. Equations (1) and (2) yield the estimating equation of the model which is as follows:

$$X_t = a_o + b_2P_{t-1} + b_3Y_{t-1} + b_4x_{t-1} + V_t \quad \text{..................(3)}$$

The relationships among the parameters of the estimating equation and the original model are given by $a_o + a\lambda$, $b_2 = b\lambda$, $b_3 = c\lambda$, $b_4 = 1\text{-}\lambda$, and $V_t = \lambda U_t$. All the variables in the estimating equation are observable excepting the random variable, V_t.

The estimating equation of the adjustment model has the same form as that derived for the expectation model. However, the advantage of the adjustment model with respect to serial correlation of the residuals can be readily seen. Since $V_t = \lambda U_t$, U_t will be serially uncorrelated if the estimated residuals V_t in Equation (3) are found to be serially uncorrelated. And, therefore, the estimated coefficients of the adjustment model are not likely to be affected by serial correlation.

In spite of the similarity in the final forms of the estimating equations, it is worthwhile to stress the distinction between the expectation model and the adjustment lag model. The former is supposed to reflect the manner in which past experience determines the expected values of the variables such as prices and yields, which in turn determine the levels of output and inputs intended by the farmers. The adjustment model, on the other hand, reflects the technological and institutional constrains (such as subsistence nature of cultivation, absence of rural credit, lack of knowledge regarding cultivation of other crops, lack of water supply and better seeds, *etc.*) which permit only a fraction of the intended levels to be realised during a given short period. In reality both types of lag are important and neither can be supposed, *a priori*, to be non-existent, which means that none of the lag coefficients, K or λ, can be assumed to be unity. Indeed, ideally a model should specify a separate lag coefficient for each expectational variable and a different adjustment lag coefficient. But such a model presents serious estimation problems[7]. In practice, therefore, we have to choose between a model which provides for an adjustment lag only and a model which neglects the adjustment lag in favour of expectation lags.

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[7] Models of this type and the difficulties involved are discussed in the Marc Nerlove [17, pp. 68-69; 19, pp. 236-240].

The adequacy of the models developed above in explaining the price response of jute farmers in India and Pakistan can only be settled empirically. We have not introduced explicitly the changes in input prices in either of the models. Lack of adequate data is the main reason for that. However, as explained earlier, the price of rice to a large extent takes account of the major elements in the cost of jute production. Moreover, the evidence furnished by the relative costs of cultivation of jute and rice in pre-Partition India and in post-Partition Indian Union and Pakistan suggests that the deflated cost of cultivation of jute has not changed significantly over time. No demand relation has also been specified while deriving the equations estimating the supply response. The implicit assumption has been that the shifts in demand and supply of jute are independent. This assumption does not seem unrealistic—insofar as fluctuations in the supply function of raw jute arising out of such causes as variation in weather, changes in agricultural techniques, and organisation or changes in governmental policy of control of jute acreage would be uncorrelated with shifts in the demand for raw jute, which are mainly for packaging and other industrial purposes. Moreover, it seems plausible that the range of fluctuations from year to year in the supply of an agricultural commodity like raw jute would be greater than the industrial demand for it[8].

III. CHOICE AND LIMITATIONS OF THE STATISTICAL DATA

Official jute statistics of India and Pakistan have long been the target of criticism for their unrealiability. Even the cursory scrutiny of official estimates shows that both the jute acreage and production series are faulty. In case of production flow data can be used to construct an independent and more reliable measure of production. For acreage, however, no such data are available, on the other hand, in order to discover the price response of acreage, the acreage data must at least be sufficiently reliable to disclose the direction of true variability or year-to-year change.

Now comparison of the official estimates of production with the flow estimate reveals a striking similarity in short term movements of the two series. Changes in official production correspond fairly well with changes in flow estimate of production. Therefore, it seems plausible that the separate changes in acreage and yield are also fairly well represented by the official data. If there were a tendency for yield change to be understated, it would have a smoothing effect on the official production data unless an offsetting bias (*i.e.*, exaggeration of bias) were present in the official acreage data. The first possibility is ruled out

[8] This is also supported by a finding of the FAO. By comparing the variations in raw jute production with variations in the industrial demand (measured by the Indian mill consumption and exports overseas) in the inter-war period, FAO found that the magnitude of variation was significantly greater in production than in industrial demand. In fact, for every 1,00,000 tons by which production varied, industrial demand varied by only 40,000 tons [4, p. 26].

by inspection and comparing the rates of changes in the two series. The second possibility does not seem possible; therefore, it can also be disregarded. The converse set of possibilities is that acreage changes are understated and that this bias is offset by overstatement of yield changes. This possibility also does not seem plausible. Therefore, we can assume that actual direction of year-to-year changes in acreage or yield rate are fairly well reflected in the official estimates of acreage and yield rates. This finding is also supported by a comparison of the official acreage with the acreage calculated by a method suggested by Sinha[9].

Thus, inspite of their limitations, the official estimates of acreage can be used in the statistical models developed earlier for analysing the price response of jute farmers in the subcontinent.

Because of the boundary changes imposed by the partition of India into Pakistan and the Indian Union in 1947, it is necessary to consider separately the pre-Partition and post-Partition price experiences of the jute farmers of the subcontinent. Actual choice of the period and regions is, however, dictated primarily by the availability of the relevant data. The required time series are available on the basis of political divisions or provinces, which have been taken as the basic geographic units of our analysis. The sources and nature of the data are described as we get along with our statistical analysis.

IV. STATISTICAL ANALYSIS OF JUTE FARMERS' PRICE RESPONSE AND INTERPRETATION OF THE RESULTS

Regression Explaining Jute Acreage in Bengal (1912/13-1938/39)

Bengal (now constituted politically by East Pakistan and West Bengal) was the largest jute-producing area in pre-Partition India and accounted for 85-96 per cent of the total jute acreage in British India. Official estimates of jute acreage in Bengal are available from the 1911/12 season onward. These have been used as the dependent variable.

Now, standardisation of the acreage or the dependent variable is an important problem in supply analysis, since considerable changes in areas may

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[9] *See* [28a]. After a study of the official jute statistics of pre-Partition India, Sinha suggested an indirect method for computing a more reliable series of all-India jute acreage. The series are based on the trade or flow estimates of all-India jute crop and the all-India average yield per acre deduced from official estimates of output and acreage. The basis of Sinha's argument was that the preparation of the official estimation of output was roughly equivalent to working out of the total out-turn of the crop from the total acreage and the weighted average yield per acre, the later being computed from average yields deduced from crop-cutting experiments with respect to smaller areas (*e.g.*, thanas). From the statistical property of weighted averages, the all-India average yield per acre may be assumed to be substantially accurate, and on this basis an approximation to the actual acreage under jute could be obtained by dividing the trade estimate of jute crop by the official all-India average yield per acre. For post-Partition period, separate estimates for Pakistan and the Indian Union can be similarly obtained.

take place which might have no relationship to price. Unless acreage is somehow standardized over time (such as using the per cent of total acres as the dependent variable), spurious results are likely. To safeguard against this possibility, regressions were run, to begin with, with jute acreage deflated by the 1) acreage under rice—the competitive crop, 2) acreage under rice and ten other crops (*viz.*, wheat, sugarcane, cotton, linseed, mustard, sesamum, barley, pulses, chillies and gram). In both the cases, the results were substantially the same as those obtained by using absolute figures of jute acreage. It was, therefore, decided to use absolute values of the jute acreage as the dependent variable. Again deflation of the acreage variable by acreage of competing crops or total crop acreage is also not full proof as one would expect, since changes in the area ratio denominator can possibly swamp changes in the numerator with variables moving in the opposite rather than in the same direction. This could happen if both the acres of competitive crops expand or contract at the expense of some other crops not being considered, and the increase or decrease in the ratio denominator exceeds that of the numerator.

Of the independent variable, the ratio of jute to rice prices relates to the ratio of the seasonal harvest price of raw jute in Bengal to the retail price of rice. The harvest price of raw jute represents average prices of jute in mofussil centres at harvest time, and is expressed originally in price per maund (82.286 lbs.). Retail price of rice (common variety) is available for five principal jute-growing centres in Bengal on a calender-year basis. To conform the rice prices to jute season (July-June period), the average (unweighted) annual prices (of the five centres) in the two calendar years in which the jute season falls are calculated for the period 1911/12-1938/39. This centering of annual average price of rice, however, to some extent understates the extent of actual variations during the jute season and is adopted here for lack of better alternative. The ratio of per acre yield of jute to rice is calculated by dividing the average official estimates of yield rate of jute (dry fibre) by the yield rate of husked rice (*aus* and *aman* varieties) in the jute-producing districts of Bengal.

Movements of jute acreage and prices of jute and rice reveal considerable fluctuations in the period of our analysis (*see* Figure 3). Jute acreage fluctuated from a low of 1,316 thousand acres in 1921/22 season to a high of 3,315 thousand acres in 1926/27. Coefficient of variation of jute acreage works out to be 19.9. Movements of both jute and rice prices are widely fluctuating and more or less parallel as is to be expected in a rural economy dominated by the cultivation of the two crops; fluctuations in jute price are, however, more violent than those in rice prices. Correlation between the two series works out to be 0.71. As argued earlier, the ratio of harvest jute prices to the retail price of rice

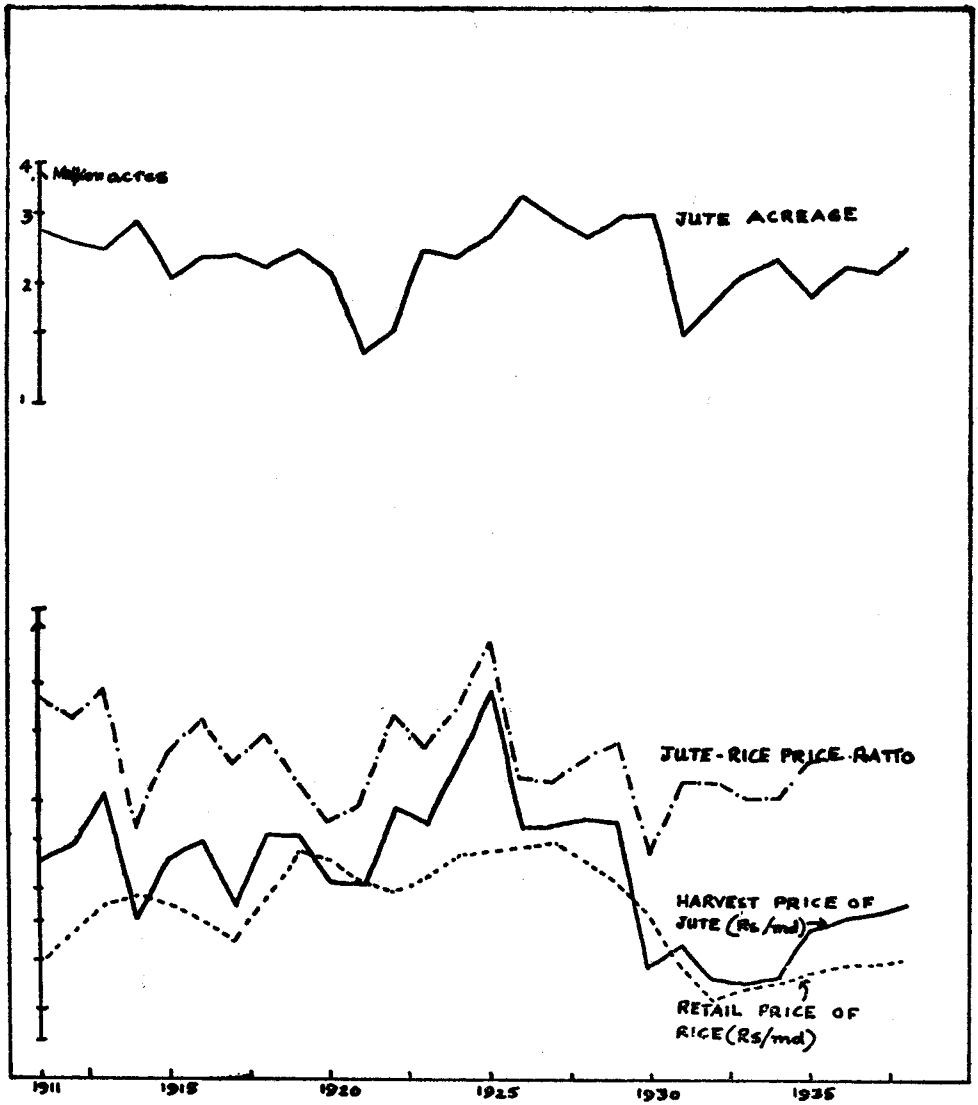

Figure 3. Movements of Jute Acreage and Related Price Series in Pre-Partition Bengal

is roughly equivalent to the deflation of jute price by an "index of prices paid by the jute farmers". The relative price of jute with respect to rice, therefore, takes into account not only the price of the substitute crop, but also the costs of inputs indirectly[10]. Scatter diagram of jute acreage and relative price of jute lagged by a year reveal *prima facie* close association between the two series although in the five seasons, 1921/22 and 1927/28-1930/31, the scatter of the points is further away from the general cluster of the points. The statistical fits of the two models, price expectation model (denoted by Regression II) and adjustment model (denoted by Regression III) are compared with the usual acreage response model denoted as the restricted model or Regression I. Regression I is, in fact, a restricted case of Regression II which assumes $K = 1$ (or, in other words, assumes that last year's relative price of jute and rice is projected by the jute farmers as their estimate of the expected price this year). Regression II is a multiple regression of current jute acreage on lagged price ratio of jute and rice and lagged acreage. K, the coefficient of expectation in this case, is estimated from combinations of the coefficients of the two explanatory variables. Regression I is a simple regression of current acreage on lagged relation price of jute and rice. Regression III is a multiple regression of current jute acreage on lagged price ratio of jute and rice, lagged acreage, and a shifter variable, lagged yield ratio of jute and rice. Regression III is done in two stages: one without including a trend variable (denoted by IIIa) and the other including a trend variable (IIIb) to take into account whatever trend there might be in the price and yield ratios.

Table IV summarises the results of the regression analysis. In the first half of the table, the regression coefficients of the explanatory variables appearing in each regression are given along with their standard errors. The constant terms in the regressions are also given, but without their standard errors. The lower half of the table summarises selected characteristics of the regressions: 1) the square of the coefficient of multiple correlation and F-statistics, 2) test of serial correlation in the residuals according to Durbin-Watson Test, 3) the estimated coefficient of expectation, K, for Regression II and coefficient of adjustment λ for Regression IIIa and IIIb, and finally 4) the long and short term elasticities of acreage with respect to relative price. All elasticities are taken at the mean values of the variables concerned.

Both price expectation and adjustment models are definite improvement upon the restricted or naive model in explaining the variation in Bengal jute acreage. Judged by the value of R^2, adjustment model IIIb has the maximum

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10 In effect this introduces a unit "opportunity cost" which gives us a ratio between output price and cost price [14, p. 128].

TABLE IV

REGRESSIONS EXPLAINING BENGAL JUTE ACREAGE: 1912/13—1938/39 (N=27)

Explanatory variables	Regression I (restricted model)	Regression II (price expectation model)	Regression IIIa adjustment model	Regression IIIb adjustment model
P_{t-1} = Price of jute (relative to rice) lagged one year	8.7289 (1.7548)	8.4165 (1.4188)	8.5352 (0.1100)	9.1783 (0.1110)
A_{lt-1} = Jute acreage, lagged one year	—	0.4296 (0.1133)	0.3904 (0.1123)	0.4188 (0.1098)
Y_{lt-1} = Ratio of yield rate of jute to rice, lagged one year	—	—	5.1991 (2.9054)	4.4716 (0.1096)
t = time trend (1912/13=0)	—	—	—	10.9036 (6.6811)
Constant	1187.0525	215.8761	—455.7766	—645.3151
R^2	0.4974	0.6857	0.7228	0.7527
F-Statistic	24.7444 d.f. 1,25	26.1756 d.f. 2,24	19.9893 d.f. 3,23	16.7408 d.f. 4,22
Serial Correlation according to Durbin-Waston Test	Serial Correlation	No Serial Correlation	No Serial Correlation	No Serial Correlation
Estimate of K	—	0.5704	—	—
λ	—	—	0.6096	0.5812
Elasticity of acreage with respect to relative price				
Long run	—	0.84	0.84	0.90
Short run	0.4944	0.48	0.4834	0.5198
Elasticity of acreage with respect to relative yield				
Long run	—	—	0.5228	0.4715
Short run	—	—	0.3187	0.2741

Note: All elasticities are taken at the mean values of the variable. First the short run elasticities are computed from the regression coefficients. The long run elasticities are then computed as follows:
Price expectation model: Long run elasticity = K × short run elasticity.
Adjustment model: Long run elasticity = λ × short-run elasticity.
Figures in parenthesis indicate standard errors of the regression coefficients.
Sources of the variables: Acreage figures are from Porter and Cooper [25].
Price figures are from [9] for rice prices and FAO [4] for jute prices.
Yield rates of jute and rice relate to the average yield rates of the jute-growing districts of Bengal and are from [12, various years.]

success. It yields an estimate of short run of elasticity of acreage with respect to relative price at 0.52 and long run at 0.90 showing that jute acreage in Bengal had been fairly responsive to relative price. The estimates are statistically significant. Price expectation model (Regression II) yields equally significant but numerically slightly lower elasticity coefficients. On the other hand, explanatory power of the restricted model is found to be rather poor; it could not explain more than 50 per cent of the variations in the dependent variable.

According to the Durbin-Watson test, residuals of Regression IIIa, IIIb, and II are free from serial correlation, while those of Regression I are not; this is in accordance with what we would expect. Now, examination of the residuals of Regression III—the equation with maximum predictive power, shows that they are particularly large for the seasons, 1921/22 and 1927/28-1930/31. These are the years when extreme variations in jute acreage occurred. It is, therefore, to be expected that the extreme variations in the dependent variable should be associated with the largest of the unexplained residuals. In a period in which there is a collapse of commodity prices, such as occurred in 1921, the adequacy of the model in explaining away the variation in acreage is rather on a less firm ground than in a period in which prices are more stable. Similar reasons explain, in part, the rather large residuals for the years, 1927/28—1930/31, when it was vainly expected that prices might return to the 1925 level. This hope was finally dashed by the 1930 depressions, after which the residuals are again smaller and more randomly distributed.

Regressions Explaining Jute Acreage in India (pre-Partition Period: 1911/12—1938/39)

Next, we proceeded to find out how far the models succeed in explaining the variations in the aggregate jute acreage in the entire jute belt of India. To take into the variations in jute-growing areas outside Bengal the explanatory variables, *viz.*, the relative price and relative yield rate were suitably modified. The relative price in this case was the weighted average of the ratios of harvest price of jute and retail price of rice (common variety) in the jute-growing district of Bengal, Assam, Bihar, and Orissa. The weights were proportional to the annual acreage under jute in each province. Similarly, the yield ratio was worked out by weighting the yield ratio of the four jute growing provinces, the weights again being proportional to the annual jute acreage in each province. However, in view of the predominant position of Bengal in the jute production of the subcontinent in the sample period, movements of the dependent and independent variables were considerably similar to those in Bengal. Two fits were attempted: one for the entire period, 1911/12—1938/39, and the other for 1921/22—1938/39. Results of the fit for 1911/12—1938/39 are shown in Table V.

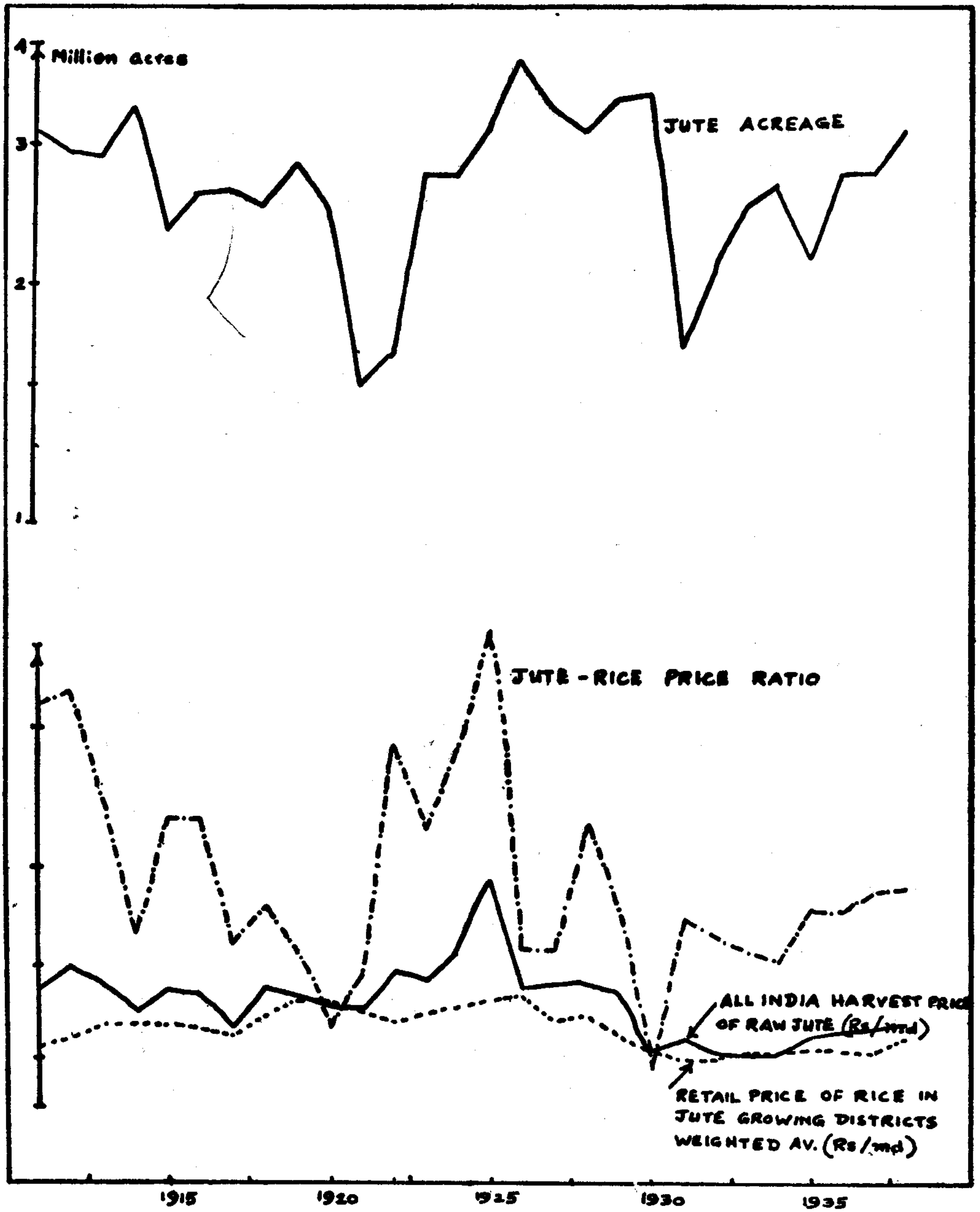

Figure 4. Movements of Jute Acreage and Related Price Series in British India

TABLE V

REGRESSIONS EXPLAINING FLUCTUATIONS IN ALL INDIA JUTE ACREAGE: 1911/12—1938/39 (N=28)

Explanatory variables	Regression I restricted model	Regression II expected price model	Regression IIIa Adjustment model	Regression IIIb Adjustment model
P_{t-1}	7.8143 (0.1495)	7.3995 (0.1285)	8.7278 (0.1223)	9.2571 (0.1247)
A_{jt-1}	—	0.4188 (0.1285)	0.3930 (0.1155)	0.4105 (0.1145)
t	—	—	—	13.1036 (9.8229)
Constant	1665.0754	566.5186	—947.6065	—781.9156
R^2	0.4185	0.5899	0.6840	0.7067
F-statistics	18.7142 1,26	17.9808 2,25	17.3173 3,24	13.8549 4,23
Elasticity of acreage with respect to relative price				
Long run	—	0.6502	0.7320	0.8020
Short run	0.3991	0.3779	0.4458	0.4728
Elasticity of acreage with respect to relative yield rate				
Long run	—	—	0.8308	0.5703
Short run	—	—	0.5043	0.3362

Note: Figures in the parenthesis indicate standard errors of the regression coefficients.

Sources: The acreage figures are from [25].
Prices of jute and rice (both weighted) are from [9].
Yield rates of jute and rice are from [12] and refer to jute-growing districts of British India.

Again the adjustment model gives the best fit, explaining about 70 per cent of the total variation of the dependent variable. The expected price model explains about 60 per cent. The adjustment model also yields higher estimates of the price elasticity as compared with the expected price model. Relative yield is an important explanatory variable besides relative price in Equations IIIa and IIIb.

If we confine our analysis to the 1921/22—1938/39 period on the assumption that the period 1911/12—1920/21 was somewhat abnormal because of the intervention of World War I, the fit of all the equations is considerably improved, as can be seen from Table VI.

The adjustment model now explains about 80 per cent of the total variations in acreage and yields an estimate of 0.50 for the short run relative price elasticity and a long run elasticity of 0.93. The elasticities of acreage with respect to relative yields are also substantial. Expected price model gives slightly higher estimates of the long run relative price elasticity than the adjustment model, although the magnitude of R^2 is lower in case of the former. The estimate of short run elasticity from the restricted model is almost the same as those from the other two models.

Our analysis so far shows that the models of supply behaviour of jute farmers which have been postulated earlier have worked well when applied to the pre-Partition data. The response of jute acreage in pre-Partition Bengal, as well as in the rest of the jute-growing tracts of India, with respect to relative price was positive and significantly high. The relative yield rate was another important explanatory variable and its inclusion as a shifter variable in the adjustment model, in general, led to higher values of R^2 and larger elasticity coefficients. This suggests that the more correctly we are able to specify the relevant non-price variables, the more significant are the net regression coefficient and elasticities of the price variable that we get. We now turn to examine the supply behaviour of the jute farmers in the post-Partition or more recent period.

Regressions Explaining Jute Acreage in East Pakistan (1931/32 and 1949/50—1962/63)

East Pakistan, which comprises the greater portion of the pre-Partition Bengal, has been the single largest area of jute production in the post-war period. However, its relative share in the total production of the subcontinent has declined in this period. Moreover, there has also been a falling trend in the total jute acreage, though only slightly, as compared with the earlier period. Separate figures for the total jute acreage in East Pakistan are available only since the 1931/32 season, although harvest prices of jute and retail prices of

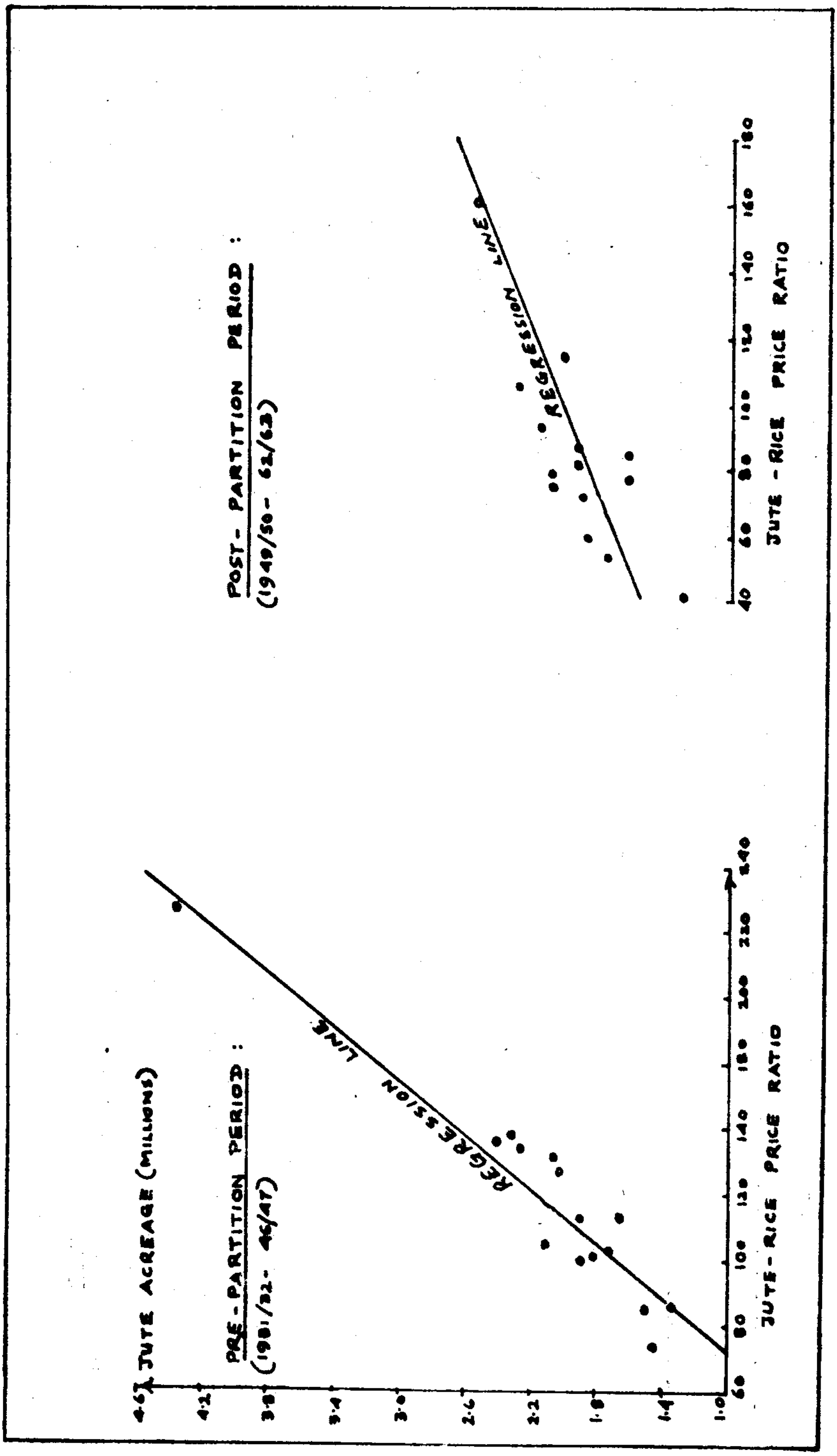

Figure 5. Price Response of Jute Acreage in East Pakistan: Scatter Diagram

TABLE VI

REGRESSIONS EXPLAINING FLUCTUATIONS IN ALL INDIA JUTE ACREAGE: 1921/22—1938/39 (N=19)

Explanatory variables	Regression I restricted model	Regression II expected price model	Regression IIIa Adjustment model	Regression IIIb Adjustment model
P_{t-1}	10.3514 (0.5812)	10.2705 (1.8943)	10.4220 (1.7438)	10.4137 (1.8084)
A_{1t-1}	—	0.5078 (0.1292)	0.4660 (0.1208)	0.4652 (0.1256)
Y_{1t-1}	—	—	9.6027 (4.8518)	10.0273 (7.7580)
t	—	—	—	—1.5127 (2.1068)
Constant	1320.7307	12.5381	—1248.6099	—1278.1964
R^2	0.4861	0.7396	0.7935	0.7936
F-statistic (degree of freedom)	16.0817 (1,17)	22.7164 (2,16)	19.2112 (3,15)	13.6561 (6,16)
Serial correlation by Durbin-Watson test	Test Inconclusive	No Serial Correlation	No Serial Correlation	No Serial Correlation
Estimate of K	—	0.4902	—	—
λ	—	—	0.5340	0.5348
Elasticity of acreage with respect to relative price				
Long run	—	0.9972	0.9300	0.9267
Short run	0.4927	0.4888	0.4960	0.4956
Elasticity of acreage with respect to yields				
Long run	—	—	0.9292	0.9692
Short run	—	—	0.4963	0.5183

Notes and Sources: Same as in Table V.

rice (common variety) relating to jute-growing districts of East Pakistan are available from the 1910/11 season onward[11].

A preliminary scrutiny of the data suggested separation of the analysis into two periods, *viz:* 1931/32-1946/47 and 1949/50-1960-1962/63. In fact, the scatter of the points on the acreage (dependent variable)—relative price (independent variable) plane is wider and calculated degree of correlation significantly lower (0.9333 in the 1931/32-1946/47 period as compared with 0.7631 in 1949/50-1962/63 period) in the later than in the earlier period. Moreover, the slope of the regression line is notably less steep in the later period, suggesting the fact that on the average jute acreage in East Pakistan has responded in a less certain and less forceful manner to the jute/rice price ratio in the post-Partition years than in the earlier period.

Now, operation of the acreage-licensing scheme for greater part of the sample period (from 1941/42 to 1959/60) poses a problem for the straightforward application of the acreage response models. The professed objective of the acreage licensing which operated from 1941/42 to 1959/60 seasons, was to keep the prices of jute from falling to the depressed level of the Thirties by acting on the supply. It was backed by authorities to destroy crops which had not been licensed. In fact, these powers were rarely used, and it is clear that the licensing system did not seriously restrict plantings. In five out of nine post-Partition years the area actually planted exceeded the area licensed. In other years, including those of the pre-Partition period, the actual plantings were much smaller than the area licensed. We can, therefore, assume that the operation of the acreage licensing *per se* did not interfere with the price response of the East Pakistan jute cultivators. However, in order to take into account explicitly whatever effect the acreage licensing might have had on the price response of the East Pakistan farmers, we can introduce in our models a dummy variable which will take the value 1 in the years in which the licensing was in operation, and 0 for the years when it was not. Results of the analysis for the two periods are given in Table VII. Table A gives the estimates of regression coefficients and their standard errors; Table B gives the elasticity coefficients. The dummy variable did not come out to be significant in both the periods, so that the analysis confirms our assumption regarding ineffectiveness of the acreage licensing. The shifter variable also did not turn out to be significant for the period 1931/32-1946/47. In the post-Partition period 1949/50-1962/63, the response of acreage to yield ratio comes out to be negative and highly significant. The (short run) price elasticity of acreage with respect to relative price ratio is found to be

[11] For price figures up to the 1954/55 season, *see* [4, Appendices J and K]. For price figures from 1955/56 season onward, *see* [22]. For acreage figures, *see* [4; 22].

exceptionally high (1.35) for the period 1931/32-1946/47; but for the 1949/50-1962/63 period it is only 0.40 and less than one-third the value of the earlier period. The exceptionally high value of the supply elasticity in the earlier period is partly due to the extraordinary variation of acreage and relative price in the 1940/41 season; however, even if these extreme values are excluded, the pre-Partition supply elasticity remains nearly twice as large as the post-Partition value. The reduction in price responsiveness of the jute farmers in East Pakistan in the post-Partition period is an indication of the growing pressure of population on the land and the consequent increase in the subsistence cultivation of rice[12]. Practically all jute moves to market and being traded for cash commands a market price, whereas vast quantities of rice are retained for immediate consumption and do not enter into price formation. The area which this rice represents is very likely to respond to prices only after subsistence requirements are met. Reduction in the supply elasticity of jute in the post-Partition period of rice shortage is, therefore, primarily due to increase in the subsistence cultivation of rice and consequent reduction in the margin of flexibility between the cultivation of the two crops. The negative response of acreage to yield ratio also lends support to this.

Regressions Explaining Jute Acreage in the Indian Union (1951/52—1961/62)

Prior to Partition, the Indian portion of the jute belt was a minor producer of jute. In the early post-Partition years in order to reduce the large "marginal" import requirement of the Indian jute industry from Pakistan, a jute self-sufficiency policy accompanied by a maximum domestic price for jute was introduced. The price offered to the farmers of the Indian portion of the jute belt of the subcontinent was highly favourable *vis-a-vis* rice since 1947 onward. The Indian jute planting (acreage) expanded sharply and by 1951/52 exceeded that in Pakistan. From then onward, however, the year-to-year fluctuations have been more significant than the secular trend.

Availability of the price (harvest prices of raw jute and retail price of rice) and yield data enable us to analyse the price response of the jute farmers in the principal jute-growing states, *viz.*, West Bengal (including Cooch Bihar), Assam, Bihar, and Orissa. Combining the variables, aggregate response of the farmers can also be studied on the all-India basis. A couple of the early post-Partition years had to be excluded from the analysis as being abnormal years; the period covered by the analysis is, therefore, rather short, and this limitation has to be borne in mind while interpreting the results. The results of our analysis are given in Table VIII.

In every case the adjustment model gave a slightly better fit than the price expectation model. This gain of the adjustment model is, however, largely illusory

12 see [30].

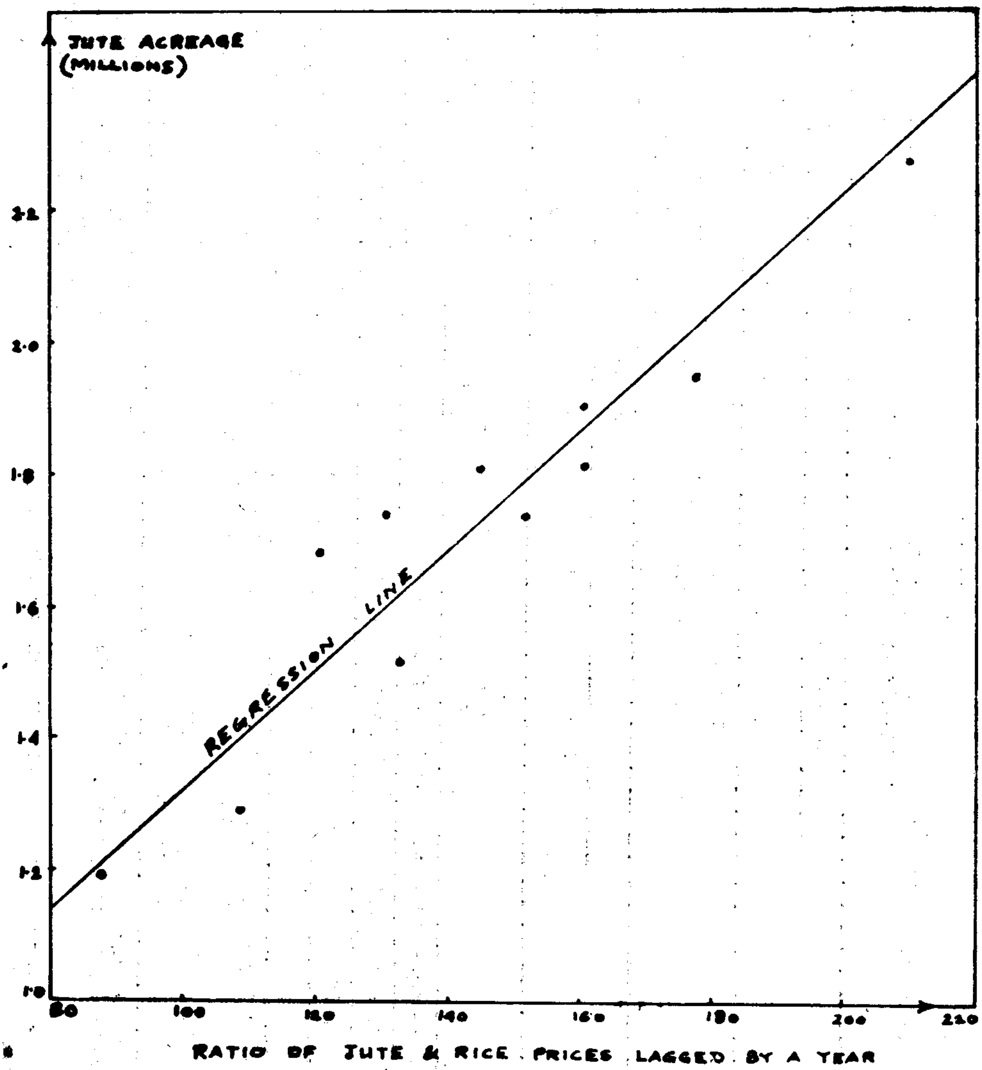

Figure 6. Price Response of Jute Acreage in Post-Partition Indian Union: Scatter Diagram.

TABLE VII

REGRESSIONS EXPLAINING THE VARIATION IN THE JUTE ACREAGE IN EAST PAKISTAN 1931/32—1946/47 AND 1949/50—1962/63

A. Regression Coefficients and R^2

Period	Restricted model		Price expectation model				
	P_{t-1}	R^2	P_{t-1}	A_{t-1}	Dummy variable	t	R^2
1931/32-1946/47	21.2614	0.8710	23.5710 (3.4865)	0.0826 (0.1041)	314.6610 (402.0710)	—29.66 (39.15)	0.89
1949/50-1962/63	7.5050 (1.8349)	0.5823	7.3764 (1.9255)	0.3907 (0.1848)	—112.5805 (132.2012)	—	0.65

Period	Adjustment model					
	P_{t-1}	A_{t-1}	Y_{t-1}	Dummy variable	t	R^2
1931/32-1946/47	—	—	—	—	—	—
1949/50-1962/63	6.3974 (0.2459)	0.3940 (0.2360)	—4.0306 (0.3809)	—58.06 (312.87)	—2.64 (25.07)	0.69

B. Elasticity Coefficients and Durbin-Watson Test for Serial Correlation

Period	Restricted model		Price expectation model			Adjustment model				
	EXP	Durbin-Watson test	EXP		Durbin-Watson test	EXP		EXO		Durbin-Watson test
	SR		SR	LR		SR	LR	SR	LR	
1931/32-1946/47	1.2173	No Serial Correlation	1.3496	1.6651	No Serial Correlation	—	—	—	—	
1949/50-1962/63	0.4101	Serial Correlation	0.4031	0.6617	No Serial Correlation	0.3946	0.6470	—0.4755	—.7795	No Serial Correlation

Note: EXP is elasticity of acreage with respect to relative price.
EXO is elasticity of acreage with respect to relative yield rates.
SR is short run.
LR is long run.
Yield rates of jute and rice refer to average yield rates in the jute-growing district of East Pakistan

Sources: Jute acreage are from [22; 6].
Jute and rice price are from [22].
Yield rates of jute are from [6].
Yield rates of rice are calculated from [21].

TABLE VIII

REGRESSIONS EXPLAINING JUTE ACREAGE IN THE INDIAN UNION AND THE PRINCIPAL JUTE-GROWING STATES (1949/50—1961/62): REGRESSION COEFFICIENTS AND R^2

Region and period	Respective model		Price expectation model			Adjustment model				
	P_{t-1}	R^2	P_{t-1}	A_{t-1}	R^2	P_{t-1}	A_{t-1}	Y_{t-1}	t	R^2
W. Bengal (1951/52-1961/62)	3.7184 (0.3499)	0.9262	3.7230 (0.3660)	0.0654 (0.1354)	0.9283	3.7126 (0.4566)	0.0161 (0.1898)	0.5086 (1.2261)	1.8580	0.93
Assam (1951/52-1961/62)	1.0136 (0.2680)	0.6138	1.1089 (0.2647)	0.2549 (0.1847)	0.6881	1.0639 (0.3119)	0.1976 (0.2324)	—0.0309 (0.5124)	0.7033 (2.5652)	0.70
Bihar (1949/50-1961/62)	2.7357 (0.4834)	0.7443	2.6603 (0.4697)	0.1877 (0.1391)	0.7837	2.6127 (0.4784)	0.0953 (0.1577)	0.3288 (0.6351)	6.3623 (4.8162)	0.82
Orissa (1950/51-1961/62)	0.3832	0.7536	0.3825	0.0131	0.7538	0.4007	0.0972	0.2367	1.1131	0.82
Indian Union (Total: 1951/52-1961/62)	8.6078 (1.0240)	0.8870	8.9783 (0.8777)	0.2514 (0.1157)	0.9290	8.7886 (0.9625)	0.2309 (0.1311)	—0.0860 (2.6801)	9.2164 (1.1269)	0.94

Notes: P_{t+1} = relative prices; for the states it is the ratio of the harvest price of jute to the retail (free market) price of rice (common variety). For the Indian Union it is the weighted average of the relative prices in the jute-growing states (W. Bengal, Bihar, Orissa, and Assam), weights being proportional to the acreage under jute in each state.

Y_{t-1} = relative yield rates; for the states it is the ratio of average yield of jute (dry fibre) and rice (all varieties, husked) per acre for the jute-growing districts. For the Indian Union it is the weighted average of the relative yield rates of the different states, weights again being proportional to the acreage under jute in each state.
A_{t-1} = lagged acreage under jute (official estimates).

Sources: Acreage and yield rates of jute for the various states and Indian Union (total) are from [6]. Special care should be taken in defining the total jute acreage in different states especially West Bengal and Bihar in view of the recent boundary changes.
The yield rates of rice and harvest prices of jute for the different states are from [7, various years].
Retail price of rice in West Bengal relate to the average annual prices for the non-rationed areas of West Bengal and are from [13].
Prices of rice for Assam, Bihar, and Orissa are from [7, various years.]

TABLE IX

ELASTICITY COEFFICIENTS FOR THE ACREAGE RESPONSE FUNCTIONS OF JUTE IN THE VARIOUS JUTE-GROWING STATES AND IN THE INDIAN UNION

Region/period	Restricted model	Price expectation model		Adjustment model			
	EXP	EXP		EXP		EXO	
	SR	SR	LR	SR	LR	SR	LR
W. Bengal (1951-61)	0.6964	0.6973	0.7433	0.6953	0.7067	0.0735	0.0750
Assam (1951-61)	0.3924	0.4293	0.5700	0.4119	0.5149	—0.0171	—0.0214
Bihar (1949-61)	0.8206	0.7980	0.9684	0.7837	0.8760	0.1006	0.1120
Orissa (1950-61)	0.7539	0.7524	0.7678	0.7884	0.8760	0.3991	0.4440
Indian Union (1951-61)	0.7247	0.7559	0.9944	0.7399	0.9600	—0.0063	—0.0082

Notes: EXP = Elasticity of acreage with respect to relative price.
EXO = Elasticity of acreage with respect to relative yield rates.
SR = Short run.
LR = Long run.
All elasticities are at the mean values of the variables.

in view of the degrees of freedom lost and non-significance of the shifter variable in most of the cases. Only in case of Orissa did the shifter variable turn out to be significant. The response of jute acreage to the relative price is found to be positive and highly significant in all the jute-growing areas of the Indian Union. The short-run elasticity of acreage with respect to relative price is found to range from 0.43 (Assam) to 0.80 (Bihar) and the long-run elasticity from 0.57 (Assam) to 0.97 (Bihar). For the Indian Union as a whole, the short-run elasticity is estimated at 0.76 and a long-run elasticity at 0.99. This is a highly significant result and is nearly twice as large as the value obtained in case of East Pakistan for the corresponding period.

We should now summarize the results of our main findings and compare them with elasticities of acreage estimated by other workers for other crops and regions. This is done in Table X.

The following conclusions may be drawn from our results. The models of farm supply behaviour which have been found to work with the data for Western countries not only do not break down when applied to the official jute data of India and Pakistan, but yield plausible, interesting and internationally comparable results. The magnitudes of our estimates of the elasticities of jute acreage in pre-Partition Bengal or India are essentially comparable with those of Sinha, Venkataraman and Stern. Stern's estimates for India which cover a more extended period are slightly higher than ours, while those of Sinha and Venkataraman covering the same period as ours, are smaller. Raj Krishna's estimates, on the other hand, show that the elasticity of cotton, another fibre crop, in the Punjab of the pre-Partition period was higher than that of jute for either Bengal or India as a whole. Comparison with estimates of Marc Nerlove or Shayal, on the other hand, suggest that elasticity of jute acreage in Bengal or India was higher than those for cotton in the United States of America or Egypt in the comparable periods.

The principal determinant of jute acreage in India or Pakistan is the jute farmer's expectation of the relative price of jute and rice that is largely based on the preceding season's ratio of the two. The relative yield of jute and rice is also an important factor in some of the regions such as East Pakistan or Orissa. The relative price and the yield ratio along with lagged acreage explain as much as 70-93 per cent of the variation of the jute acreage. The response of jute farmers to relative price has tended to vary over the years. In East Pakistan, it has tended to decline somewhat as comparison of the price elasticities of acreage in the pre- and post-Partition periods suggests. In the Indian Union, on the other hand, it has tended to increase as judged by the coefficient of adjustment; the jute farmers of the Indian Union have been successful in rapidly

TABLE X

SUMMARY OF FINDINGS AND SOME REGIONAL AND INTERNATIONAL COMPARISONS

Commodity and period	K	λ	Price elasticity of acreage	
			Short run	Long run
Jute: our estimates*				
Bengal: 1912/13-1938/39	**0.48**	**0.52**	**0.52**	**0.90**
All India: 1911/12-1938/39	**0.58**	**0.61**	**0.38**	**0.65**
1921/22-1938/39	**0.49**	**0.54**	**0.50**	**0.99**
East Pakistan: 1949/50-1962/63	**0.60**	**0.60**	**0.40**	**0.65**
West Bengal: 1951/52-1961/62	**0.9381**	**0.9839**	**0.6973**	**0.74**
Assam: 1951/52-1961/62	**0.7533**	**0.8024**	**0.4293**	**0.57**
Bihar: 1949/50-1961/62	**0.8240**	**0.9047**	**0.7980**	**0.97**
Orissa: 1950/51-1961/62	**0.9876**	**0.9028**	**0.7524**	**0.77**
Indian Union: 1951/52-1961/62	**0.7602**	**0.7691**	**0.7559**	**0.99**
Jute: other workers				
A.R. Sinha: All India, 1921/22-1938/39	—	—	0.65	—
Venkataraman: All India, 1911/12-1938/39	0.64	—	0.46	0.73
R.N. Stern: All India, 1893/94-1938/39	0.66	—	0.68	1.03
Bengal, 1911/12-1938/39	—	—	0.76	—
Raj Krishna:				
Punjab, Cotton, 1921-41	—	0.44	0.7	1.62
Sugarcane, 1951-43	—	0.56	0.34	0.60
Rice, 1916-45	—	0.52	0.31	0.59
Marc Nerlove,				
USA, Cotton, 1900-32	—	0.51	0.34	0.67
Wheat, 1909-32	—	0.52	0.48	0.93
Corn, 1909-32	—	0.54	0.10	0.18
S.M. Shayal: Egypt, Cotton, 1899-1914	—	—	0.16	—
L.R. Klein: Brazil, Cotton, 1921-1940	—	—	0.65	—

*Because of the large similarities in the values of the price elasticity of acreage obtained by the two models, only those of the expectation model are quoted here.

A.R. Sinha: [28].
L.S. Venkataraman: [33].
R.M. Stern: [32, p. 206].
Raj Krishna: [15].
Marc Nerlove: [18, pp. 496-509].
S.M. Shayal: [27].
L.R. Klein: [14, p. 129].

adjusting the jute acreage upward in response to the changing circumstances after the Partition[13].

V. DETERMINANTS OF LONG-TERM TRENDS OF JUTE PRODUCTION IN INDIA AND PAKISTAN

On the basis of our analyses we are now in a position to identify the long-term determinants of jute production in India and Pakistan. The trends of jute acreage in pre-Partition India are seen to follow closely the trend of jute-rice price ratio. Since there was hardly any trend, upward or downward, in the yield rate of jute in this period, the production of jute is also found to follow closely the jute-rice price ratio[14]. Absence of any response of acreage to relative yield rate in this period also strengthens the association of the trend of production with the trend in the jute-rice price ratio.

In the same way, the long-run decline in jute acreage as observed in the case of East Pakistan is found to be largely due to the long-term fall in the price of jute in East Pakistan relative to the price of rice.

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13 *See*[31].

14 This can also be proved algebraically as follows:

Let A_t=jute average, S_t=supply (production of raw jute by growers in period t), Y_t=average yield rate of jute. Then $S_t=A_tY_t$. Differentiating S_t with respect to expected price (relative to rice) of jute, P^*_{jt}, we have

$$\frac{dS_t}{dP^*_{jt}} = Y_t \frac{dA_t}{dP^*_{jt}} + A_t \cdot \frac{dY_t}{dP^*_{jt}}$$

Multiplying both sides by $\frac{P^*_{jt}}{S_t}$ we have $\frac{P^*_{jt}}{dp^*_{jt}} \cdot \frac{dS_t}{dP^*_{jt}} = Y_t \frac{dA_t}{dP^*_{jt}} + A_t \cdot \frac{dY_t}{dP^*_{jt}} \cdot \frac{P^*_{jt}}{S_t}$

or

or

$$\eta S_t P^*_{jt} = \eta A_t P^*_{jt} + \eta Y_t P^*_{jt}$$

or

in other words, elasticity of supply of raw jute with respect to expected price is the sum of elasticities of acreage and yield with respect to expected price. If $\eta\, Y_t\, P^*_{jt} = 0$, $\eta\, S_t\, P^*_{jt} = \eta A_t\, P^*_{jt}$

TABLE XI

TREND OF JUTE ACREAGE AND PRODUCTION IN BRITISH INDIA 1921/22—1939/40

5-year average	Acreage (000)	Yield rate lbs./acre	Output (000 m.t.)	Relative price (jute/rice)
1921/22—1925/26	2398	1154	1730	136
1926/27—1930/31	3454	1245	2479	152
1931/32—1935/36	2275	1275	1671	105
1936/37—1939/40	3025	1156	1984	140

Source: Acreage: Porter and Cooper [25].
Yield rate: [12].
Output: trade estimates, calculated from [26, Chapter I].
Relative price: calculated from [4].

The fall in the relative price of jute in East Pakistan has been due to sharp increase in the relative price of rice, which rose rapidly during World War II and again by 2½ times between 1954/55 and 1957/58. Rice production has lagged behind population growth in East Pakistan, with only a small increase in rice acreage and with no perceptible increase in yield rate up to 1959/60. Since 1960/61 the price of rice seems to have been kept from rising much further first by increased imports of rice and then by the exceptionally good harvest both in 1959/60 and 1960/61. In 1960/61, the price of jute shot up to record levels and the jute-rice price index rose with it, but the subsequent decline in the price of jute brought the index back to close to previous level. On the production side apparent improvements in yield rate have to some extent offset the decline in the jute/rice price ratio so that the long-run fall in production is not so pronounced.

Under the existing conditions production of jute in East Pakistan is primarily a choice between a cash crop and the food crop. The total acreage under rice (*aus* and *aman*) in East Pakistan is of the order of 20.0 million acres or about 88 per cent of the total cultivated area in the 1947-61 period. As against this the jute acreage is about 6 per cent. Thus, if jute acreage is curtailed by 50 per cent, it can at best add about 4 per cent to the rice acreage. At the same time, if 3 per cent of the rice acreage is diverted to jute, it can add as much as 40 per cent to the jute acreage. A curtailment of 3 per cent of the rice acreage will mean in physical terms a shortage of about 0.3 million tons of rice at the present yield rate out of an annual production of about 10.0 million tons or about 3 per cent of the normal output. In the sixteen years between 1947/48-1962/63, the

TABLE XII

TREND IN JUTE ACREAGE AND PRODUCTION IN EAST PAKISTAN

Period	Acreage (000 acres)	Yield rate (lbs./acre)	Output (000 m.t.)	Relative price (jute/rice)
1936/37—1940/41	2592	1198	1349	147
1941/42—1945/46	1803	1234	1008	102
1946/47—1950/51	1750	1188	1057	109
1951/52—1954/55	1505	1464	994	87
1955/56—1959/60	1443	1544	1095	71
1960/61—1962/63	1716	1344	1065	89

Sources: Acreage: For 1947/48-1962/63, [22]. For 1936/37-1940/41 [4].
Yield rate: For 1947/48-1962/63, [22]. For 1936/37-1940/41, [4].
Output: from 1947/48 relates to trade of flow estimate of production and is from [2, various issues]. For 1936/37 to 1946/47 production is estimated by FAO [4].
Relative prices calculated from [22].

annual variation of jute acreage in East Pakistan has been about 20 per cent of the mean annual jute acreage (the maximum upward variation has been about 29 per cent), so that the maximum probable diversion of the rice acreage to jute has not even exceeded 2 per cent of the normal rice acreage. Although cultivation of jute in East Pakistan means better utilization of the land[15], on balance the production and price of rice is likely to continue to be the main limiting factor in the long run supply of jute in East Pakistan unless there is substantial

TABLE XIII

TREND OF JUTE ACREAGE AND PRODUCTION IN THE INDIAN UNION POST-PARTITION PERIOD

5-year average	Jute acreage (000 acres)	Yield rate (lbs./acre)	Output (000 m.t.)	Relative price (jute/rice)
1947/48—1951/52	1202	992	647	—
1952/53—1956/57	1550	972	732	135
1957/58—1961/62	1806	1064	899	148

Sources: Jute acreage and yield rate: [6].
Output: relates to trade estimate of production: [2].
Relative prices: calculated from [7].

[15] This view was also shared by the Pakistan Jute Enquiry Committee. *See*, [23, p. 38].

increase in yield rate of jute. On the other hand, the negative response of acreage to relative yield rates, as we have observed, would imply further shrinkage of jute acreage if yield rate of jute shows any significant gains over yield rate of rice, with the prices of jute and rice remaining relatively stable.

Finally, the rapid increase of jute production in the Indian Union in the post-Partition period has been brought about largely by the favourable jute/rice price ratio in the early post-Partition years and the rapid adjustment of the jute farmers in response to the changing circumstances. Jute acreage was increased primarily by permanent diversion of rice land, which seems to have completed its course by the 1951/52 season. From then onward, the trend in jute acreage has closely followed the trend of jute/rice price ratio. Unless offset by an improving trend in the yield rate, the future variations in jute acreage and, therefore, production, are likely to be ruled largely by the variation of the jute/rice ratio.

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